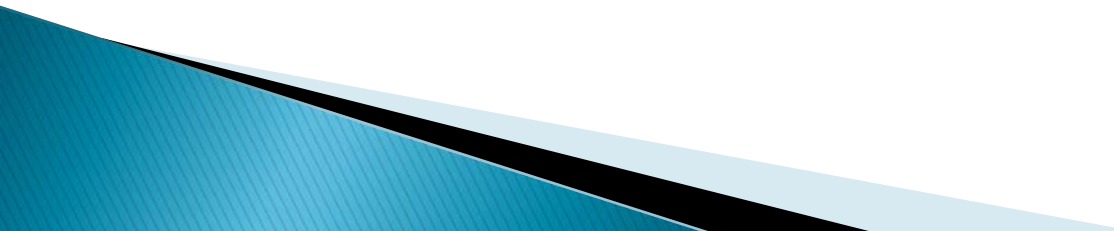




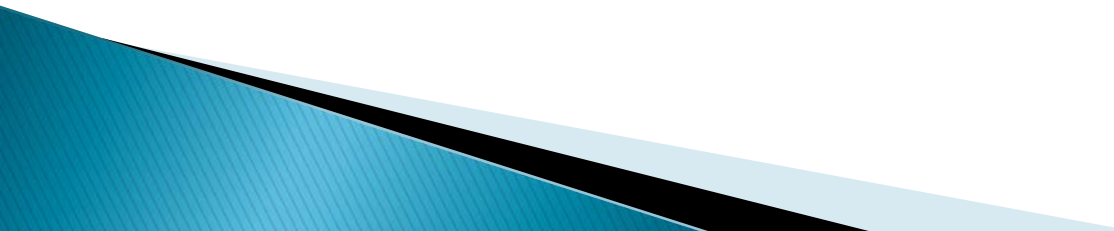
Standard 6X: Design Calculations for Pressure- Containing Equipment

New Draft Standard under Subcommittee 6
John H. Fowler, P. E. – Owner, On-Line Resources


History and Objective

- ▶ API 6A, 16A, and 16C reference the ASME Code Section VIII Division 2, 2004 Edition, Appendix 4 as one acceptable method for design verification.
 - ▶ Since referencing an obsolete spec is awkward, an Annex (Annex I) was prepared for 16A capturing the method from that ASME Appendix.
 - ▶ Subcommittee 6 proposed that the method be put in a separate document to assure uniformity.
- 

Scope of Document

- ▶ Document covers calculation methods only.
 - ▶ Applicable only to specified pressure containing components, i.e. bodies, bonnets, and end connectors.
 - ▶ No material property requirements
 - ▶ No quality control requirements
 - ▶ The product specifications may also permit the use of other methods.
- 

2004 ASME Code Requirements

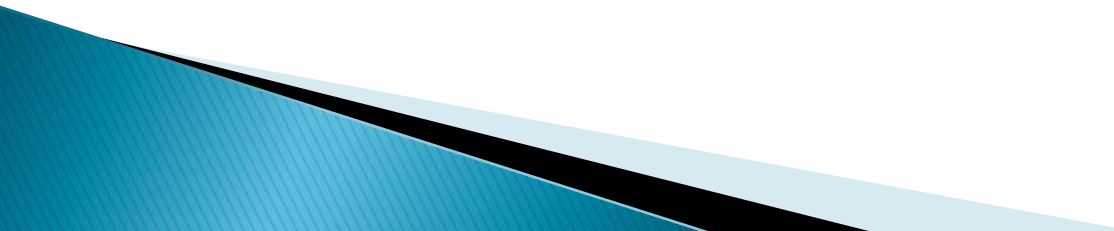
- ▶ Methods were provided for linear elastic analysis, non-linear limit analysis, and elastic/plastic finite-element analysis
 - ▶ Linear elastic analysis defined stress categories and allowable limits for each. Stress components were combined into stress intensities.
 - ▶ Limit analysis assumed an elastic, perfectly plastic material and determined the collapse loading.
 - ▶ Elastic analysis was based on the true stress/true strain data and was used to verify shakedown.
- 

Task Group Charge

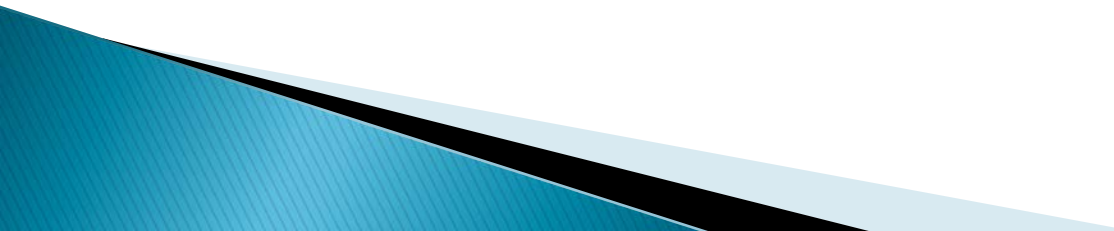
- ▶ Create a new API standard documenting the rules of the 2004 ASME Code.
- ▶ Problem: 16A and 6A use different allowable stresses.

| Stress value | Spec 6A requirement | Spec 16A requirement |
|----------------------------------|---------------------------------|----------------------|
| Max SI at test pressure | $5/6$ of S_y | 90% of S_y |
| S_m for standard materials | $2/3$ of S_y | $2/3$ of S_y |
| S_m for non-standard materials | Lower of $2/3 S_y$ or $1/2 S_u$ | $2/3$ of S_y |

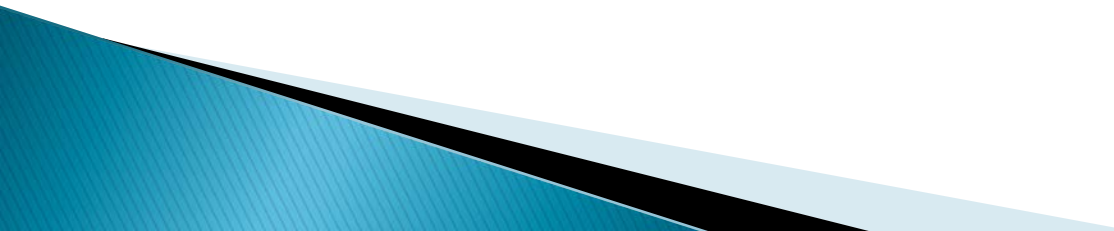
Resolution

- ▶ The task group consensus was to use the rules of 16A, since going to the slightly more conservative 6A rules would penalize 16A/16C users who had designed to higher allowable stresses.
 - ▶ The 90% of S_y used in 16A and 16C is the same as the limit in the 2004 ASME Code Section VIII Division 2 part AD-151.1(a).
 - ▶ Using only the yield strength as a basis follows Section VIII Division 3 practice.
- 

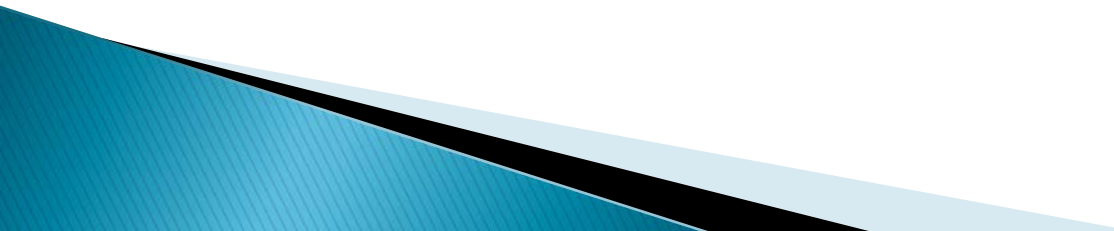
Changes from Annex I to 6X

- ▶ 6X is derived from API 6A, Annex I.
 - ▶ Several revisions were made to the Annex I to clarify the requirements.
 - ▶ The uses of limit analysis and elastic/plastic analysis were clarified.
 - ▶ The requirement regarding triaxial stress (the sum of the three principal stresses) was clarified as to the calculation basis.
- 

Items not covered

- ▶ Design of bolting is not included since it is covered in new bolt specifications (API 20E).
 - ▶ Fatigue is not covered since only API 17D requires fatigue analysis.
 - ▶ Material properties and quality control are not included since they are covered differently in the product specifications.
 - ▶ Rules for non-standard materials are not covered since API 6A addresses this.
- 

Status of 6X

- ▶ The TG finalized the draft and agreed it was ready for ballot.
 - ▶ API edited the document into standard API format and returned it to the TG for review.
 - ▶ After review the draft standard was be sent out for ballot by SC6, with an April 30 deadline.
 - ▶ SC 16 and SC 17 solicited comments from their member companies, which were considered along with those from SC6 members.
- 

Status of the balloting

▶ 3 Ballots needed

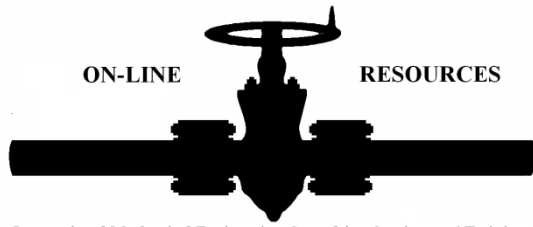
- First ballot passed, with four negative votes and over 150 comments made and resolved.
- Second ballot – API to re-ballot since there were so many technical changes. Second ballot also passed, with two negative votes, and over 100 comments and resolved.
- Third ballot – Again, because of technical changes, it was decided to re-circulate a third time. Third ballot passed with no negative votes and only 34 minor editorial comments.

Revisions due to the ballot comments

- ▶ An introduction was added to give background of the standard.
- ▶ Stress components may be combined using von Mises equivalent stress (vs. stress intensity) if permitted by the product specification.
- ▶ Removed the note that if the material has a high yield/tensile ratio a lower S_m value may be used. This makes the S_m determination exactly like in 16A and 16C.
- ▶ Vague language in several places strengthened to clarify mandatory requirements.
- ▶ An “Extreme Conditions” paragraph was added providing the “k” factor from the 2004 Div 2.

Follow-on actions

- ▶ After publication of the Standard
 - Specifications 6A, 16A and 16C should revise their design section to direct the designer to this new standard instead of the 2004 ASME Code.
 - This may require several changes in the body of the specifications.
 - Since 17D refers to 6A for design requirements, no change is needed, unless they want to permit the use of von Mises equivalent stress.
 - The 2004 ASME Code Section VIII Division 2 can be removed from the product specifications as a referenced standard, and Standard 6X added.



Contact information

- ▶ John H. Fowler, P. E.
- ▶ Owner, On-Line Resources
 - P O Box 925393, Houston, TX 77292
 - Phone 713-688-0767
 - Fax 713-688-7610
- ▶ Web page www.OLREngineering.com